**Introduction to Computer Vision, 2013**

**Final Exam**

- Answer the following 3 questions.
- You may write your answers either in Hebrew or in English.
- Length of exam: 3 hours.

**Good luck!**

Q1:

1. Is it possible to discretely sample a function $f : \Re \longrightarrow \Re$ at uniform finite distances without loosing any information? (i.e., can we sample $f(x)$ discretely, and be able to reconstruct the complete $f(x)$ back from its discrete samples?) Explain when.
2. $f(x)$ is a continuous function whose maximal frequency is $\Omega$. The following operations are performed on the continuous function $f(x)$. For each case, explain what is the maximal allowed distance between samples in order not to loose any information:
   (a) Stretching of $f$ by a factor of 3:
   $g(x) = f(x/3)$.
   (b) Shifting $f$:
   $g(x) = f(x - 5)$.
   (c) Differentiating $f$:
   $g(x) = f'(x)$.
   (d) Squaring $f$:
   $g(x) = f^2(x)$.
3. Is the following function band limited, and if so, what is its maximal frequency?
   $g(x) = sin(x) * cos(2x)$
   ('$*$' denotes convolution).

Q2:

1. Two **stationary** video cameras record a scene containing a flat road and a moving ball. The road is dark and has bright markings all over. The cameras are distant from each other. The cameras may have different zooms and different orientations, but both view the road and the moving ball. Assume that the cameras are temporally synchronized (i.e. their frames are taken at the same time). There are two different dynamic scenarios:

   (1) The ball *hops* from one side of the street to the other along a straight line.

   (2) The ball *rolls* from one side of the street to the other along a straight line.

   For each one of the above dynamic scenarios, please answer the following questions:

   (a) What is the appropriate geometric relation which can be computed between the two sequences? (a homography, an essential matrix, or none of the above)

   (b) What is the minimal number of point correspondences required in order to recover this relation?

2. How do your answers change if there are no markings at all on the road?

3. How do your answers change if the two camera are attached to each other, so that the distance between their focal centers is negligible? (both for the case where there are markings on the road, and for the case where there are no markings on the road).

Q3:

1. Describe briefly what is SVM.

2. Describe briefly a star model for recognition using HoG descriptors.